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ABSTRACT

This self-instructive workbook focuses on the identification of a set of classification abilities related to learning. It utilizes written materials, videotapes, and students, and is supplemented by a program and support system which includes instruction, teaching experiences for practice, discussion, and individual conferences. The three major goals of this workbook are to enable the teacher to (1) use a clinical method to administer, at any grade level, diagnostic tasks related to classification abilities, (2) identify the developmental level each student in the class has attained in terms of classification abilities; and (3) select, from resources available, subject matter appropriate to identified levels of development. Classification ability tasks are included which deal with different types of sorting and reclassification. The workbook contains outlines for eight self-workshops, some of which involve (1) assessing the ability to administer classification tasks, (2) administering classification tasks to students, (3) identifying levels of classification abilities, and (4) matching experiences to levels of development. The workbook also includes exercises in identifying classification abilities related to mathematics, in introducing the concept of "horizontal instruction," and in pictorial and symbolic sorting. There is a section dealing with a review of research on classification abilities and a bibliography. (BD)

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LEARNING ABOUT.....SERIES

Developed by

Lawrence F. Lowery

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learning about learning: classification abilities

A PERSONAL WORKSHOP

by

Lawrence F. Lowery

This self-directed, personal workshop focuses upon the identification of a set of abilities related to learning. The set, described as classification abilities, is not independent of but is distinct from other sets of abilities described in other books in the *"Learning About ... Series."* Although you will learn many ideas and develop various skills from experiencing this workshop, three major goals are identified below.

As a result of this workshop, you will be able to:

1. use a clinical method to administer, at any grade level, diagnostic tasks related to classification abilities.

2. identify the developmental level each student in your class has attained in terms of classification abilities.

3. select, from resources available, subject matter (content and manipulative materials) appropriate to identified levels of development.

Hopefully you will become able to determine levels of development by observing students during their normal activities without relying upon the administration of the tasks.

This workshop is self-instructive. It utilizes written materials, manipulative materials, videotapes, and students in your classroom. It is supplemented by a program and support system which includes instruction, teaching experiences for practice, discussion, and individual conferences.

The value of this and other books in the series depends upon the use of the presented ideas in instructional situations.

This booklet on Classification Abilities is one of several being developed under the general heading *"Learning About ... Series"* by the University of California Cooperative Teacher Preparation Project (UCCTPP).

This project, a new instructional model for teacher education, is being implemented through cooperation of the School of Education of the University of California at Berkeley, the Lawrence Hall of Science, and the Mt. Diablo and Vallejo Unified School Districts. Approximately 45 beginning teachers, both elementary and secondary, spend one year of pre-service preparation and their first two years of classroom teaching within the program. The project represents an effort to manage a much larger portion of the beginning teacher's experience than has hitherto been attempted. One major objective of the project is to assist new teachers and the experienced teachers working with them in becoming regular evaluators of their own instruction. Participants in the program are taught to use materials and techniques that help assess stages of intellectual development in students, to identify and prescribe learning activities commensurate with their students' intellectual development, and to use techniques for assessing their interactions with students. The research objective of the project is to determine the effectiveness of the model program in developing the instructional style of beginning and experienced teachers.

The *"Learning About ... Series"* is being developed through the resources of the School of Education and Lawrence Hall of Science, University of California, Berkeley. The research dimension is being funded through a National Science Foundation grant.

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INTRODUCTION

The process of classifying lies at the very heart of human learning and sets man apart from most primates and other animals. Scientists use the process whenever they define scientific concepts or use taxonomies. Each of us uses it whenever we think, for every word we speak, hear, read, write, or think denotes a group or class of objects or ideas. In an attempt to understand his world, man has become proficient in this process, making it one of the most powerful tools he has for producing and arranging information about his world.

In its behavioral form, classifying is exemplified by the ways through which we make sense of our environment by realizing "what things go together." In its cognitive form, it is the ways through which we mentally structure the sensory input from our environment. Many psychologists believe that the behavioral and cognitive forms may be tightly interwoven because organizational abilities, such as sorting and grouping, appear to be preliminary and necessary for effective conceptualization to take place.

It is known that in the early levels of development, children tend to be perceptually oriented and seem to be able to use an organizational ability which allows them to sort objects on the basis of certain characteristics, but not others. For example, in our culture the ability to sort objects on the basis of color is the earliest to appear. By age 7, the ability to sort by shape is predominant (Goldman, 1963). Sorting by such characteristics as pattern (design on an object) is next, and then

size (Johnson 1969). The sorting of objects by the materials of which they are made or by other abstract characteristics, such as molecular structures, develops much later. It is also known that at early levels, children group objects on the basis of single characteristics. The ability to use two or more discrete characteristics simultaneously as a basis for classifying is a higher level process that most children are not able to perform until about the fourth grade (Sigel 1966). Thus the ability to group objects by single perceptual characteristics develops early, then becomes less important in the child's organizational repertoire; the ability to group by more than one characteristic simultaneously or to group by abstract characteristics that are relatively autonomous of personal experience, develops later. It should be noted, however, that although early abilities recede into the background, they never disappear completely. Some become less useful and less available to the individual as more effective forms of organizing take their place, but when an individual encounters a "new" situation, he may return to basic organizational abilities in order to render it comprehensible.

Developmental theory suggests that the ability of students to deal with physical and mental organizations by creating classes, by breaking down classes into subclasses, and by reorganizing classes on alternative bases is a crucial cornerstone of logical thought. During the elementary school years, children acquire the competency to add classes of items together, to multiply classes, to divide classes into smaller units, to expand classes,

and to think in terms of classes that include or go together (in combination) to make up other classes.

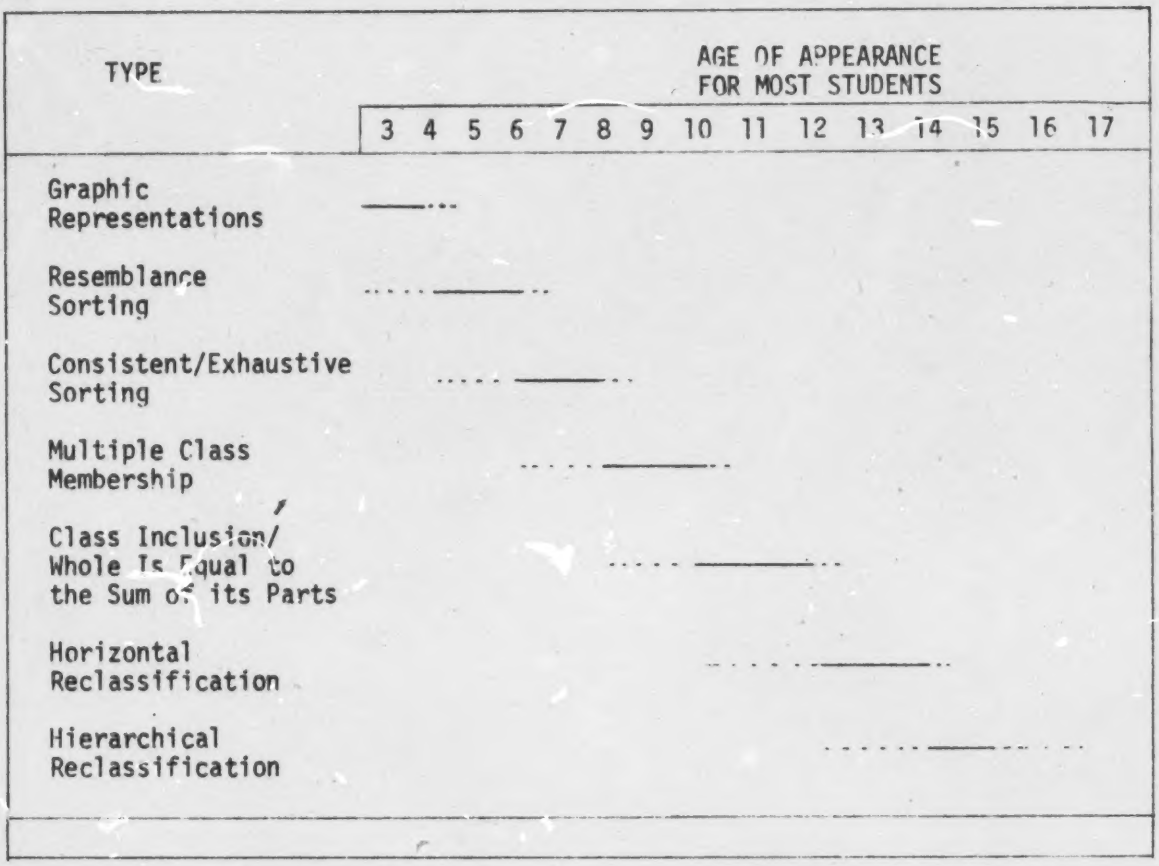
It has seemed reasonable for some time that the organizing process is actually made up of a variety of definable abilities and that these abilities proceed through ordered levels of development. Inhelder and Piaget (1964) propose that intellect develops in an invariant sequential order and that the student must proceed through an irreversible series of levels from infancy through adolescence in order to achieve the type of logical thinking usually associated with adults. Piagetian theory implies that certain prerequisites are necessary before subsequent competencies can appear. For example, a student cannot learn addition until he has learned the concept of number (Sigel 1964; Peel 1960).

Among the specific abilities Piaget has identified pertaining to classification, some disagreement still exists concerning their placement in this developmental sequence. The following list represents only the identified abilities for which there is a broad agreement among psychologists as to the order of development (Kofsky 1966; Allen 1967).

Inability to Classify	Graphic Representations: Individual arranges objects randomly, indicates no system suggesting an organ; rational plan although the final arrangement might be a design or might represent something such as a face or a train.
Pre-Classifying Abilities	Resemblance Sorting: Individual can group two objects together on the basis of one common attribute such as color, shape, or size.
	Consistent and Exhaustive Sorting: Individual can group all the objects in a set on the basis of one common attribute. The individual will not inter-mix criteria within a grouping.
True Classifying Abilities	Multiple Class Membership: Individual can classify an object into more than one category at the same time.
	Class Inclusion/Whole is Equal To The Sum of Its Parts: Individual can include one class of objects within a super-ordinate class.
Flexibility In Classifying Abilities	Horizontal Reclassification: Individual can classify then reclassify objects in different ways, realizing that each way is possible at the same time.
	Hierarchical Reclassification: Individual can classify and reclassify hierarchies of increasingly more inclusive classes.

TYPES OF CLASSIFICATION ABILITIES

SEQUENCE OF APPEARANCES


TYPE
AGE OF APPEARANCE FOR MOST STUDENTS
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Graphic Representations
Resemblance Sorting
Consistent/Exhaustive Sorting
Multiple Class Membership
Class Inclusion/ Whole Is Equal to the Sum of its Parts
Horizontal Reclassification
Hierarchical Reclassification

Summary

Classifying is the orderly arrangement of objects in ways according to their characteristics. The objects of each group have one or more characteristics in common.

All of us apparently go through an invariant sequence of developmental cognitive levels each of which determines the limit to which we are capable of making organized order out of the objects of our world.

With a friend, take turns trying each of the classification ability tasks in this section.

At first, try to use the suggested dialogue that accompanies each task, then gradually incorporate your own style.

NOTE: It is a good procedure to be sure students can recognize the colors before beginning the tasks. The tasks have been designed so that the most common cases of colorblindness will not interfere with doing them.

resemblance sorting

Principle

Two objects can be grouped together because they are alike on the basis of one common attribute. For example, from a pile of leaves, two maple leaves can be put together because they are alike on the basis of shape. Most students attain this ability by age 4 - 6.

Materials

1 small square (1" sides)* - blue.

2 medium squares (1-5/8" sides) - 1 black, 1 red.

3 large squares (2" sides) - 1 red, 1 orange with white dots, 1 orange with a white cross.

1 small circle (7/8" diameter) - orange.

11 medium circles (1-1/8" diameter) - 3 blue, 3 orange, 2 black, 2 red, 1 red with white dots.

3 large circles (2" diameter) - 1 blue, 1 red, 1 orange.

3 small triangles (3/4" sides) - 1 black, 1 black with white horizontal stripes, 1 blue with white horizontal stripes.

2 medium triangles (2" sides) - 1 orange, 1 red.

1 large triangle (3-1/4" sides) - blue

2 medium rectangles (2-1/4" x 1-5/8" sides) - 1 black, 1 blue.

3 large rectangles (4" x 2") - 1 black with a white cross, 1 blue with a white cross, 1 orange with white horizontal stripes.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

Procedure

E shows four sets of eight objects consecutively to S. For each of the sets, the shapes, colors, sizes, or patterns of objects are chosen so that S is forced to match on the basis of only one attribute.

Set 1

E places eight objects on the table in front of S:

2 squares (1 large, red; 1 small, blue).

6 circles (2 medium, blue; 2 medium, black; 2 medium, orange).

E directs the attention of S to the large red square. S is asked to select from the seven other objects, one which is "similar to" or "most like" it.

S is then asked to state the reason for his choice.

*NOTE: The sizes on this and subsequent tasks are suggestions. Such terms as "small", "medium", and "large" are the important factors for distinguishing size.

Set 2

E removes the previous set and places eight new objects on the table in front of S:

1 circle (small, orange).

2 squares (1 medium, black; 1 medium, red).

2 rectangles (1 medium, black; 1 medium, blue).

3 triangles (1 large, blue; 1 medium, red; 1 medium orange).

E directs the attention of S to the small, orange circle. S is asked to select from the seven other objects, one which is "similar to" or "most like" it.

S is then asked to state the reason for his choice.

Set 3

E removes the previous set and places eight new objects on the table in front of S:

1 triangle (small, black).

7 circles (1 small, orange; 1 medium, orange; 1 medium, red; 1 medium, blue; 1 large, orange; 1 large, red; 1 large, blue).

E directs the attention of S to the small, black triangle. S is asked to select from the seven other objects, one which is "similar to" or "most like" it.

S is then asked to state the reason for his choice.

Set 4

E removes the previous set and places eight new objects on the table in front of S:

1 circle (medium, red with white dots).

2 triangles (1 small, black with white horizontal stripes; 1 small, blue with white horizontal stripes).

2 squares (1 large, orange with white dots; 1 large, orange with a white cross).

3 rectangles (1 large, black with a white cross; 1 large, blue with a white cross; 1 large, orange with white horizontal stripes).

E directs the attention of S to the medium, red circle with dots. S is asked to select from the seven other objects, one which is "similar to" or "most like" it.

S is then asked to state the reason for his choice.

Analysis

For Set 1, S must disregard color and size, and match on the basis of shape.

For Set 2, S must disregard shape and size, and match on the basis of color.

For Set 3, shape and color must be neglected, and matching is done by size.

For Set 4, attributes of shape, color, and size must be disregarded, and matching is done by pattern.

If S correctly matches within at least three of the four sets, he is probably at or beyond the resemblance sorting level of development.

consistent/exhaustive sorting

Principle

All objects in a set are grouped on the basis of one common attribute. For example, if some objects are grouped on the basis of shape (i.e., all circles are put together), then all objects are grouped on the basis of shape (i.e., all squares are put together, all triangles are put together, etc.). Most students attain this ability by age 6 - 8.

Materials

6 triangles (2-1/4" sides) - 1 brown, 2 red, 1 blue, 2 orange.

5 squares (1-5/8" sides) - 1 red, 2 blue, 1 orange, 1 yellow.

4 circles (1-7/8" diameter) - 1 blue, 1 orange, 1 yellow, 1 red.

4 white plates.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

Procedure

E shows two sets of objects consecutively to S.

Set 1

E places twelve objects on the table in front of S:

5 triangles (1 brown; 1 blue; 1 orange; 2 red)

4 squares (1 blue; 1 orange; 1 red; 1 yellow)

3 circles (1 blue; 1 orange; 1 yellow).

E: *"Select objects that are alike."*

If S chooses a group to which only two objects belong (e.g., yellows), S is encouraged to choose another group of objects. If S selects two objects from a potentially larger group, S is encouraged to add to the group. S can use as many objects for one group as S wishes.

Set 2

E removes the previous set and replaces it with nine new objects:

4 triangles (2 orange; 2 red)

3 squares (2 blue; 1 orange)

2 circles (1 blue; 1 red)

4 white plates.

E places the blue circle on a white plate and says: *"Find all the objects like the one on the plate, and place them on the plate also."*

When the plate has been filled with as many objects as S wishes, it is removed to prevent S from shifting criterion. The procedure is repeated until all the objects are used.

Finally, the plates are returned, and S is asked to describe the contents of each and give a reason for the grouping used.

Analysis

For Set 1, S must choose three or more objects, all possessing a common attribute, to indicate consistency in the criterion used.

For Set 2, S must make three to five exhaustive sorts - either triangles, squares, circles, or browns, red, blues, oranges, yellows - to indicate that S is at or beyond the consistent and exhaustive sorting level of development. More specifically:

a. Each of the objects in the original set of nine must be assigned to a group.

b. Within each group, each object must possess the same attribute.

c. Every object that was in the original set of nine and that possesses the attribute on which objects were sorted into a group is included in that group.

d. The same general type of attribute is the criterion for all sortings. If one group consists of similar shapes, so do the others.

e. The same number of attributes serve as criteria for each group. If one group is defined by the joint presence of two attributes, so are the other groups.

multiple class membership

Principle

An object can belong to more than one class or set at the same time. Most students attain this ability by age 8 - 10.

Materials

4 large triangles (4" sides) - 2 red, 2 yellow.

4 small triangles (2" sides) - all red.

3 paper bags.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

E places 8 triangles in this order in front of S:

E makes sure S understands the term *triangle* and recognizes the colors.

Procedure

E shows one paper bag and says: *"This is a bag in which only red objects (things) can be placed. Do the small objects you see belong in this bag or not?"* NOTE: All the small blocks are red.

After S responds, E asks for justification: *"Why do you think so?"*

E shows a second paper bag and says: *"This bag is only for triangles. Do the yellows belong in this bag?"*

After S responds, E asks for justification then asks: *"Do the reds belong in the bag for triangles?"*

After S responds, E again asks for justification.

E shows the third paper bag and says: *"This bag is only for small triangles. Do the yellows belong in it?"*

After S responds, E asks for justification.

Analysis

S's explanations must involve an accurate description of the attribute that the class in question and the objects in the bag share. If S correctly answers and explains three out of the four questions, S is at this level of development and can conceive of objects as simultaneously having more than one attribute.

Alternative Procedure

One of Piaget's research designs utilizes twenty-one picture cards: 3 ducks, 4 birds that are not ducks, 4 animals that fly but are not birds, 7 animals that do not fly, and 3 inanimate objects.* E asks S to arrange the picture cards in piles so that the animals resembling each other are in the same pile.

E asks: *"Suppose these picture cards were put into this envelope labeled BIRDS. Could these cards (ducks) and these (other birds) be put into the envelope and still keep the label?"*

E then asks: *"Suppose these picture cards were put into this envelope labeled ANIMALS. Could these cards (birds) be put in with these (animals that do not fly) and still keep the label?"*

Using the same envelope, E asks: *"Could these (animals that do not fly) be put in with these (birds other than ducks) and still keep the label?"*

Next, E asks: *"If all the ducks were killed, would there be any birds left? If all the birds were killed, would there be any ducks left? If all the animals were killed, would there be any birds left?"*

E asks S to justify his responses after each question (e.g., If S rejects the bird label for ducks, S is asked: *"Aren't ducks birds?"* If S rejects the animal label for birds, E asks: *"Are not birds animals?"*

*Inhelder, B. and J. Piaget, The Early Growth of Logic. New York: Norton, 1969.

class inclusion/whole is equal to the sum of its parts

Principle

If one class is included in another, then all the smaller class is but a part (some) of the larger. Conversely, some (a part) of the larger class is all of the smaller. For example, 18 boys and 17 girls are subclasses which comprise the total number of students or superordinate class within a room. Most students can compare the extensions of two or more classes which share some properties and understand their relationship in terms of *all* and *some* by age 10 - 12.

Materials

5 triangles (2" sides) - 3 red, 2 blue.

4 squares (2" sides) - all blue.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

Procedure

E places the nine objects in mixed-up order in front of S, then procedes to ask a series of questions. After S responds to a question, E asks for justification.

Question 1: *"Are all the reds triangles? Why do you think so?"*

Question 2: *"Are all the triangles red? Why do you think so?"*

Question 3: *"Are all the squares blue? Why do you think so?"*

Question 4: *"Are all the blues square? Why do you think so?"*

Question 5: *"Which of these ways would use more blocks: 1) using the reds and blues together; 2) using the squares and triangles together; or 3) using either combination? Why do you think so?"*

Analysis

The materials used in this task were designed so that the blues can be subdivided into squares and triangles; i.e., the superordinate class blue (A) can be broken down into two subordinate classes, squares (B) and triangles ($\overline{B}$). B (squares) is the larger of the two subclasses. Also, the triangles ($\overline{B}$) consist of subclasses red (C) and blue ($\overline{C}$).

To be considered at this level of ability, the student must correctly respond to four out of the five questions posed by the experimenter. Some acceptable responses might be as follows:

Question 1: *"Yes, there are no red squares."*

Question 2: *"No, some are blue."*

Question 3: *"Yes, there are no red squares."*

Question 4: *"No, some are triangles."*

Question 5: *"There are as many reds and blues together as squares and triangles so that either method would use the most blocks."* Such a response indicates that the student understands that there are as many objects in a superordinate class as there are in all of the subclasses.

horizontal reclassification

Principle

An array of objects can be classified into groups using one set of attributes and can be reclassified on the basis of another set of attributes. For example, a set of rocks grouped on the basis of size and shape can be regrouped in a different way on the basis of color and texture. Most students attain this ability by age 12 - 14.

Materials

1 (2" x 2" x 3/4") red, wooden block.

1 (1" diameter) red, rubber ball.

1 (1" diameter) red, round, wooden checker with a central hole.

1 (1/2" diameter) red, round, transparent, plastic checker.

1 (1" diameter) red, round, opaque, plastic checker with a ridged periphery on both surfaces.

1 (1/2" diameter) opaque, glass marble, white with red stripes.

1 (1/2" diameter) black, opaque, glass marble.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

Procedure

S is presented with a set of seven objects. Each of the seven can be removed because it has one attribute that is different from all the others, and the remaining six objects can be classified on a single, common attribute. The attribute on which the remaining six objects can be grouped varies, depending upon the object removed:

a. The wooden block is square, all the rest are round.

b. The rubber ball is soft, all the rest are hard.

c. The wooden checker has a hole in it, the rest are entire.

d. The transparent checker is transparent, the rest are opaque.

e. The ridged checker is rough, the rest are smooth.

f. The white and red marble has two colors, the rest have one color.

g. The black marble is black, the rest are red or partly red.

E successively removes the single objects and asks S to supply an attribute common to all the remaining objects. Negative statements of the following type are not acceptable: when the square is removed the remainder are described as *"not square."* Two exceptions permitted are for the removal of the wooden checker with a hole and for the transparent plastic disc. When the former is removed it is acceptable to describe the remaining objects as *"not having holes"*, and when the latter is removed it is acceptable to describe the remaining objects as *"can't see through them."*

The total task is designed to determine whether S can see differences and similarities among objects and can change the basis for grouping objects.

Analysis

A student at this level of development should be able to supply an acceptable reason for grouping the objects in at least five of the seven groupings. NOTE: The student should reason that each member of the six objects in each grouping possesses the same criterial attribute and this attribute must not be included in the isolated (seventh) object. For example, it is not acceptable for a student to state that all the remaining objects are shiny, or that all are playthings, or that all make a noise when dropped.

hierarchical reclassification

Principle

Objects or events may be arranged and rearranged into useful hierarchies of increasingly more inclusive classes. The fewer the attributes used to define the class, the more inclusive or general the class. For example, the class of red squares is included in the class of squares. Most students attain this ability by age 14 or 15.

Materials

2 triangles (3" sides) - 1 white, 1 black.

4 squares (2" sides) - red, white, orange, yellow.

3 rectangles (2" x 1") - red, orange, yellow.

5 circles (2" diameter) - red, white, black, orange, yellow.

Task

The student (S) is sitting opposite or alongside the experimenter (E).

E places all the objects on the table in four groups: squares, circles, triangles, rectangles.

Procedure

E: *"Make 3 groups out of these 4 groups. If you move one object in a group, you must move all the objects in that group."*

After S has regrouped the objects, E asks for justification: *"Tell me why you grouped them in that way."*

After S has given his rationale, E says: *"Combine these 3 groups into 2 groups and tell me your reason for your new grouping."*

After S has regrouped the objects into two groups and states his reason, E says: *"Now make one group and tell me your reason for this group. Explain why this group is possible."*

Analysis

S demonstrates competence in hierarchical reclassification if he can at least combine four groups to form three and three to form two and is able to give a satisfactory reason for each combination.

The following pages contain several self-directed workshops.

Except for the first workshop, the order in which they are done, the number that are done, and the time it takes to do them are up to you.

WORKSHOP **A**

assessing the ability to administer classification tasks

The purpose of this personal workshop is to guide you in practicing the tasks shown in the previous section. After finishing this workshop, you should be able to use a clinical method while administering the tasks.

Study the Guidelines on the next page, then select a student in your classroom. Administer one or more classification tasks which you feel are appropriate to his stage of development.

Prepare an audio- or videotape of your administering the tasks.

At your leisure, review the recording and use the self-assessment sheet on page 23 to guide your analysis of your use of the clinical method. Save the recording, then after further practice, compare a later recording to it.

Use the space below to jot down personal notes about your practice experiences.

SOME GUIDELINES FOR ADMINISTERING CLASSIFICATION TASKS

1. Purpose. The purpose for administering classification tasks is to determine the nature of the student's thinking concerning classification.

2. Situation. The tasks are best administered on a one-to-one basis in a private place.

   Prior to the administration of the tasks, be sure the student understands the terms to be used or adjust your presentation to use the student's terms.

3. The Clinical Method. When you administer the tasks, ask the student questions which refer to concrete objects which the student has in front of him.

   To obtain behavioral as well as verbal responses, have the student manipulate the objects and give a rationale for his ideas.

   During the task, ask questions which challenge the student's idea in order to determine how firmly the student holds his belief or why he believes as he does. Do this in a supportive, accepting, and non-judgmental way. Do this without leading the student through the questioning.

   The questioning strategy used is not standardized and should remain flexible. As you observe the student's manipulation of objects, listen to his responses and form an hypothesis about the student's thinking. Use your questions to test your hypothesis and, if necessary, to form other hypotheses about the student's idea. If the student doesn't appear to understand a question, rephrase it.

   Be careful not to talk too much. This might possibly confuse the student or lead him into a particular line of thought. Give the student ample time to respond to the questioning. Pause as long as necessary, and do not rush the student's thinking by asking a new question.

SELF-ASSESSMENT: USING THE CLINICAL METHOD	
Assessment Considerations	Personal Notes
a. What aspects of the interview indicated that I was non-judgmental and accepting of the student's ideas?	
b. What examples in the interview indicated that I avoided leading the student toward an idea I had?	
c. What evidence is there that I let the student's responses and actions guide the discussion?	
d. What evidence indicates that I approached the student where he/she was and responded to the situation independently of adult expectations of how he/she should act?	
e. What evidence indicates I formulated hypotheses concerning the student's strategies and tested the hypotheses through manipulations of the materials?	
f. In what ways did I check for justifications?	

WORKSHOP **B**

administering classification tasks to students

The purpose of this personal workshop is to guide you in administering classification tasks to students in your own classroom. After finishing this workshop, you should be able to administer the tasks and record the responses of the students.

Use the suggested record sheet on the next page (or a variation of it) to obtain data on several students in your classroom.

Videotape one of your sessions so that the experience can be added to your collection of videotapes.

Have a staff member discuss your tape with you, especially your use of the clinical method.

Additional copies of the record sheet are found in the Appendix.

RECORD OF CLASSIFICATION TASKS

Student _____ Age _____

Administered By _____

TASK	STUDENT'S RESPONSES	B	T	A	ADMINISTRATOR'S COMMENTS	DATE
Resemblance Sorting						
Consistent & Exhaustive Sorting						
Multiple Class Membership						
Class Inclusion/ Whole Is Equal To The Sum Of Its Parts						
Horizontal Reclassification						
Hierarchical Reclassification						

NOTE: B = Below Level
T = Transition
A = At or Above Level

WORKSHOP **C**

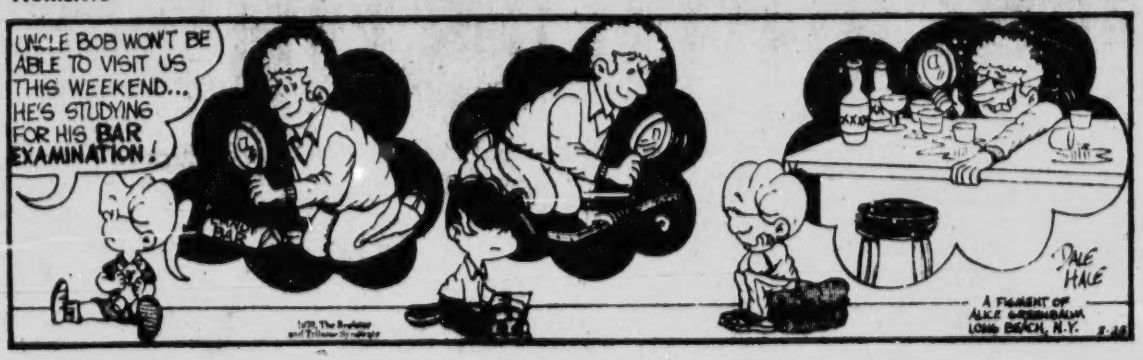
identifying cognitive operations related to classification abilities

The purpose of this workshop is to give you practice in identifying cognitive operations in a different context. After this workshop, you should have a greater skill in transferring what you have learned to new situations.

Read the comic strips below. Each ends on a humorous point that requires attainment of a particular cognitive level for understanding. Try to explain each humorous point in terms of what you have learned in this program.

When finished, check your thinking with the general explanation given on the following page.

FIGMENTS —By Dale Hale


UNCLE BOB WON'T BE ABLE TO VISIT US THIS WEEKEND... HE'S STUDYING FOR HIS BAR EXAMINATION!
DALE HALE
A FIGMENT OF ALICE GREENBAUM
LONG BEACH, N.Y.

PRISCILLA'S POP by Al Vermeer

YANKEE DOODLES —By Ben, Fred and Dan

B.C. —By Johnny Hart

FUNKY WINKERBEAN — By Tom Batiuk

I THOUGHT I'D BAKE SOMETHING FOR OUR NEXT 'RAP CELLAR' MEETING, JAN!
ARE YOU GOING TO MAKE IT FROM SCRATCH, MARCIA?
NO! I TRIED IT ONCE, BUT THE GRAVEL RUINED MY MIXER!
BATIUK
2-6

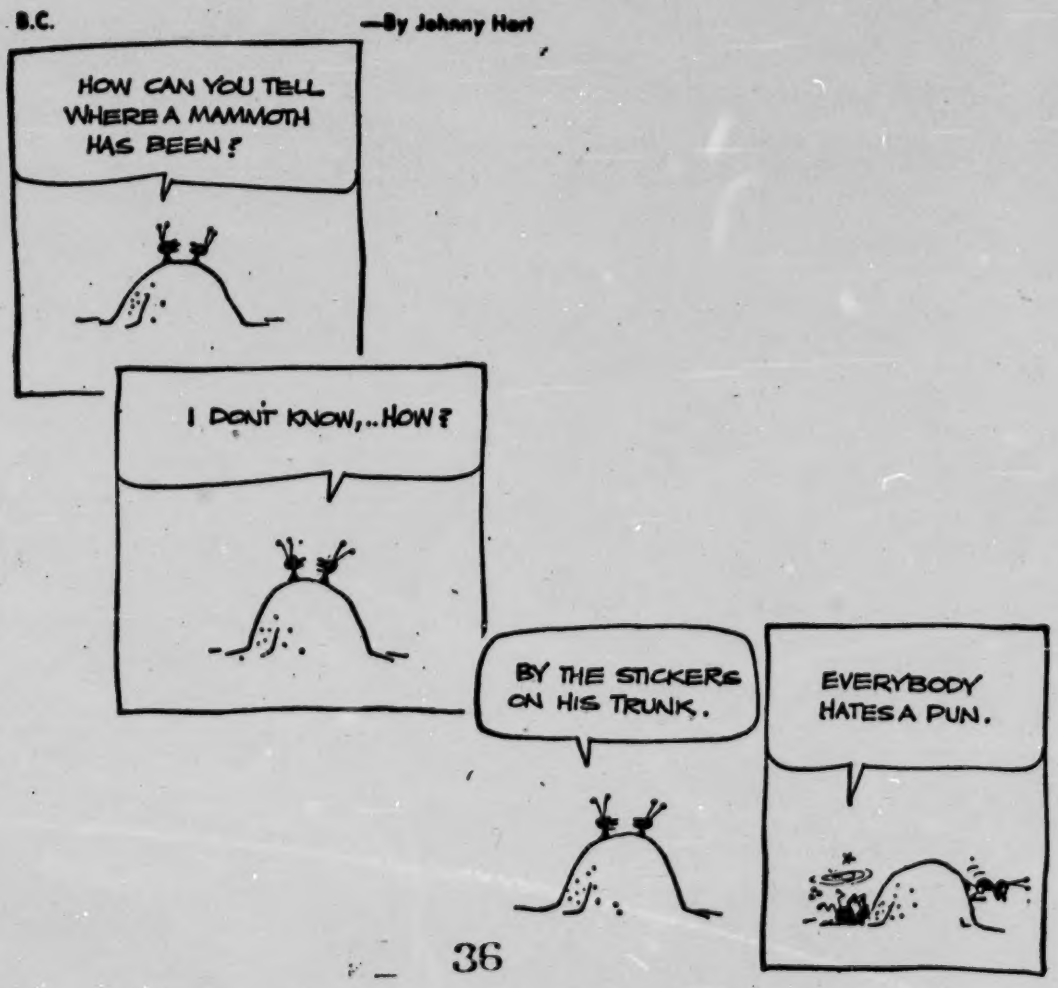
WIZARD OF ID —By Parker and Hart

ANALYSIS OF COMIC STRIPS

To understand the humor in each of these comic strips, the reader must be at least at the multiple class membership level of cognitive development.

Multiple meanings are often used as a form of humor. A multiple meaning may range from a simple visual pun (Comic #1), verbal pun (#2) or combination (#3) to a very complicated relationship of several simultaneous thoughts (#6).

It should be clear that the words "bar examination" or "a good stiff belt" require the recognition of more than one meaning. All puns and much humor require the simultaneous recognition of multiple meanings.

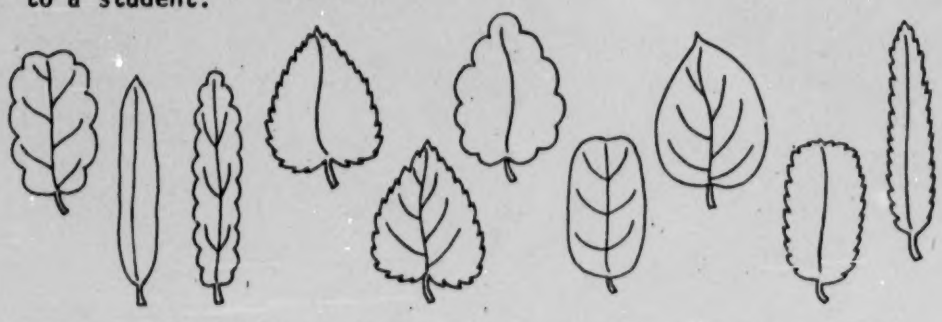

B.C.
—By Johnny Hart
HOW CAN YOU TELL WHERE A MAMMOTH HAS BEEN?
I DONT KNOW,..HOW?
BY THE STICKERS ON HIS TRUNK.
EVERYBODY HATES A PUN.

WORKSHOP **D**

identifying levels of classification abilities

The purpose of this workshop is to give you practice in identifying cognitive operations in a different context. After this workshop, you should have a greater skill in recognizing what you have learned in new situations.

The illustration below represents a set of objects that might be given to a student.

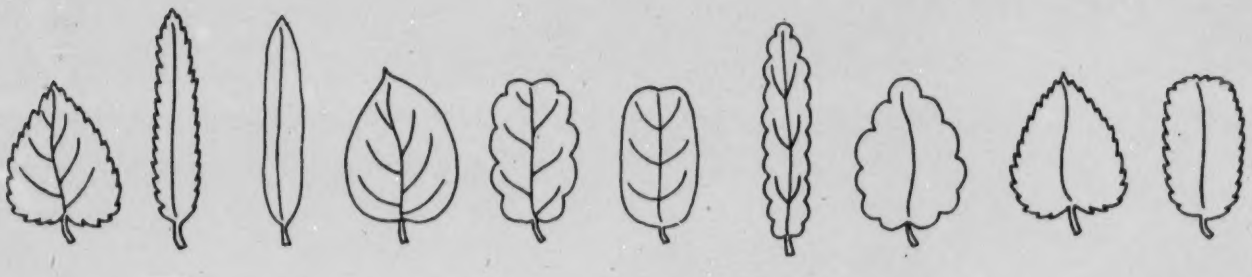


As the objects are picked up, moved, sorted, and rearranged, you might observe differences in performance. The differences are reflective of thinking strategies and may be highly individualized. The final arrangement that a student makes will not be representative of a "correct" or "incorrect" solution but will be an indication of the student's level of intellectual development.

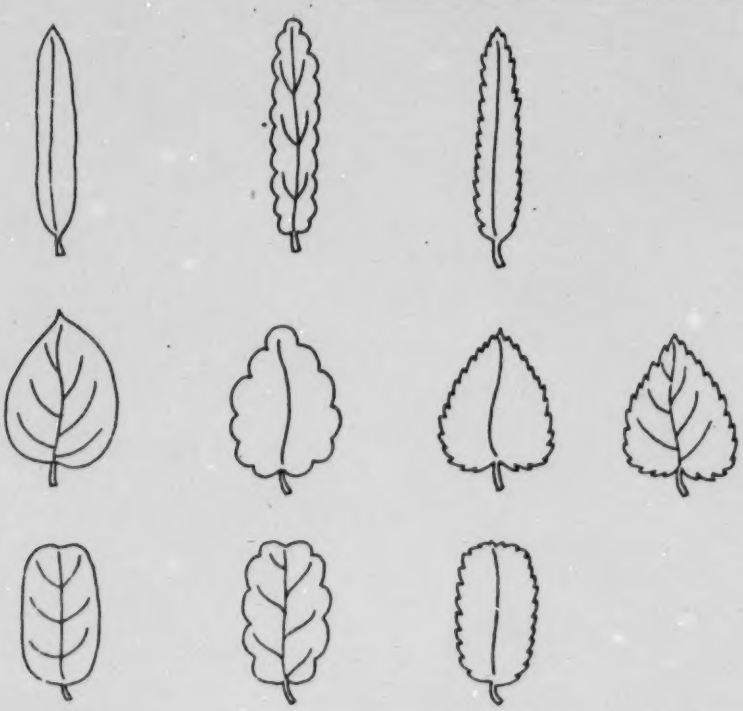
For each of the illustrations on the next two pages, try to identify the level at which the student performed. NOTE: In reality, a teacher should talk with the student about an arrangement, for the arrangement itself does not reveal all the thinking that might have taken place.

You may wish to check your identifications with those of the staff. Their identifications follow the illustrations.

1. Level of classification ability:_____

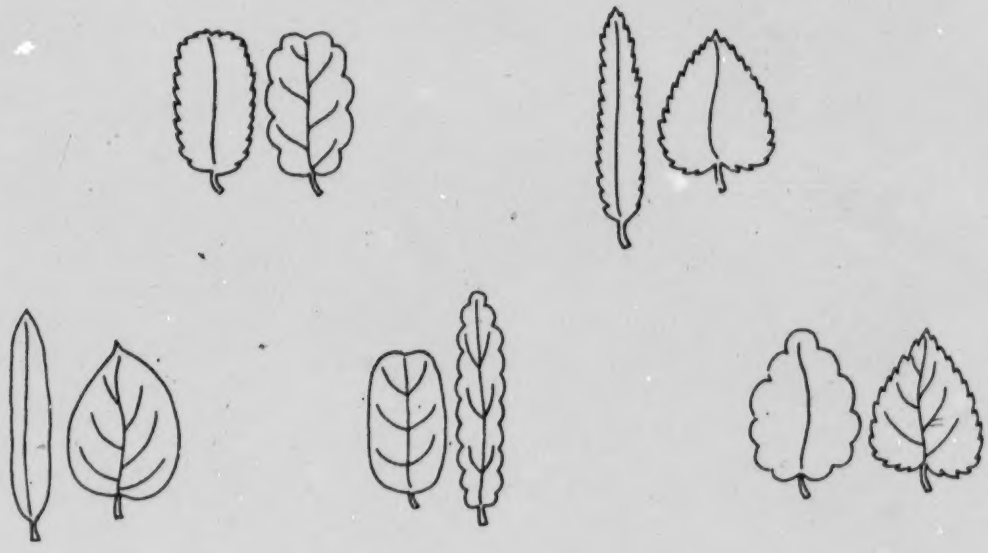


2. Level of classification ability:_____

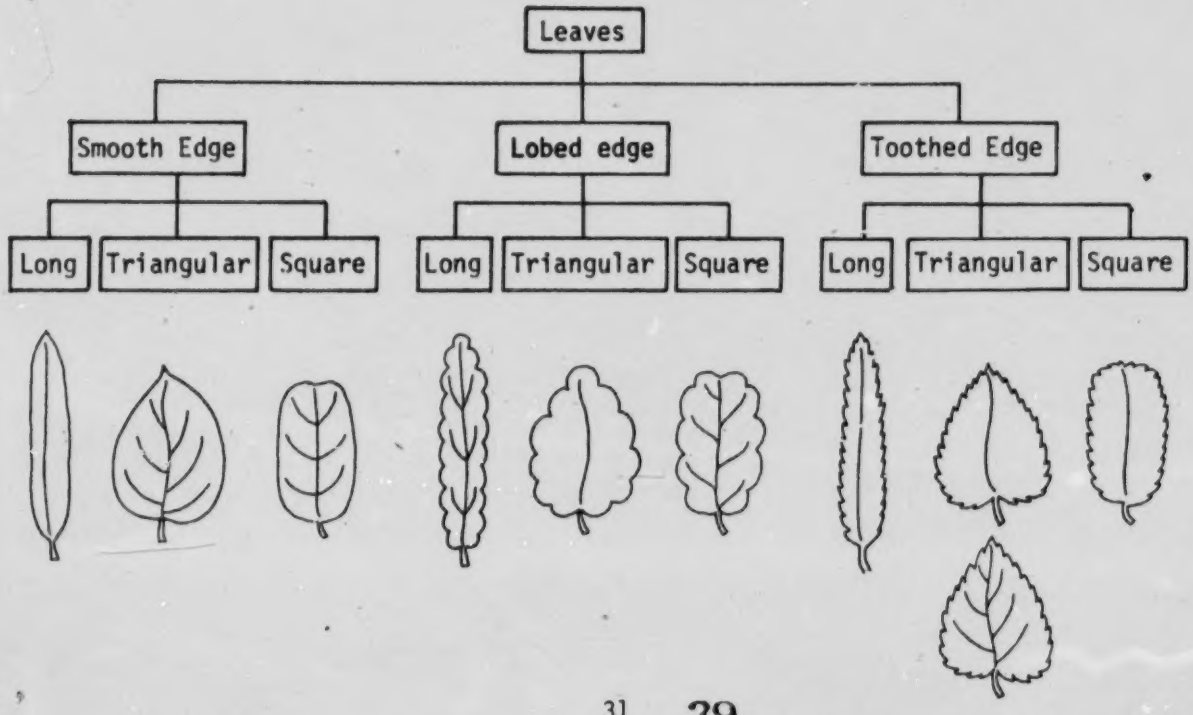


3. Level of classification ability:_____

4. Level of classification ability:_____



5. Level of classification ability:_____



ANALYSIS OF LEAF CLASSIFICATIONS

1. Resemblance Sorting Level. Note that the leaves are sorted in overlapping pairs (e.g., The first pair is sorted by serration; second pair by shape; third by serration; fourth by venation; etc.). The shifting of criteria is an indicator of a student being at the resemblance sorting level. Another indicator is that the materials are arranged in one-to-one relationships.

2. Multiple Class Membership Level. This arrangement indicates an integrated grid involving intersections of two or more properties for most of the leaves. For example, the leaf in the upper left corner fits into two sets simultaneously - the top row of leaves on the basis of shape and the left hand column on the basis of serration. The realization that an object possesses two or more properties simultaneously is an indicator of a student being at this level of development.

3. Consistent and Exhaustive Sorting Level. In this arrangement, all the leaves are sorted on the basis of one property - venation. Consistency in criterion and arrangement of the whole set are two indicators of this level of development.

4. Resemblance Sorting Level. The leaves are arranged in one-to-one relationships, each pairing involving only one property common to both leaves. Since the criterion varies among the different pairings, the student is not yet at the next level of development which involves consistency of criterion.

5. Hierarchical Reclassification Level. The leaves have been classified into groups and sequentially subgrouped to produce a hierarchical arrangement in which each subgroup has membership in more inclusive supraordinate groups. The ability of the student to rearrange the total set into a hierarchy involving other criteria would be an indicator of this level of development.

WORKSHOP **E**

observing the administration of classification tasks

The purpose of this workshop is to provide additional practice in assessing levels of development and in analyzing interviewing procedures. After finishing this workshop, you should be able to better identify levels of conservation abilities.

View the UCCTPP videotape on Classification Abilities with several other teachers. The tape will show students at different levels of cognitive development responding to a classification task.

When you finish viewing the tape, discuss the following with your colleagues:

1. What behaviors indicated each student's developmental level?

2. What verbal responses and actions distinguished the different levels of development?

3. Use the assessment sheet on page 23 to analyze the clinical method used by the interviewer. Did the interviewer lead the student into a particular line of thought? Did the interviewer rush the student's thinking?

WORKSHOP **F**

relating games to levels of development

The purpose of this workshop is to give you further practice in identifying cognitive operations in a different content. After this workshop, you should be able to use your assessment skills more broadly.

The following represent a few card games which most students learn to play.*

In order to be played effectively, each game requires that the student has reached a particular level of development. In terms of classification abilities, try to identify the levels of development. Discuss your judgments with colleagues.

*Hoyle, Official Rules of Card Games. United States Playing Card Company, Cinn., Ohio, 1970.

Go Fish

(Fish, Go Fishing, Authors)

Number of Players—Two to five.

The Pack—52 cards.

The Draw—Any player deals one card face-up to each player, and low deals, the cards ranking from A (high) to a 2 (low).

The Shuffle and Cut—Dealer shuffles the cards and the player at his right cuts them.

The Deal—Cards are dealt one at a time to the left, beginning with eldest hand. With two or three, each player receives seven cards; with four or five, each receives five. The remainder of the pack is placed face down on the table to form the *stock*.

The Play—Eldest hand begins by saying "(John), give me your kings," addressing by name any of the other players, and naming any rank provided he himself holds at least one card of that rank. The player addressed must hand over all the cards asked for, but if he has none, he says, "Go fish!" and the asker draws the top card of the stock.

When a player has had to fish, without making a catch, the turn to ask passes to his left.

level { The object in play is to form *books*. A book is any four-of-a-kind, as four kings. On getting the fourth card of a book, the player shows all four, places them on the table before himself, and plays again.

If the asker gets one or more cards of the named rank from the player addressed, he asks again. He may address the same or any other player and name the same or any other rank. So long as he is successful in getting cards, his turn continues. Also, if when told to fish he gets the fourth card of the book in the rank named, he shows the book and his turn continues. (*Variant.* Some like to play that the turn continues when the fisher gets the card named from the stock, even though it does not complete a book.)

The game ends when the ownership of all thirteen books has been decided. If one player is left without cards, he may in turn draw from the stock and ask for cards of that rank, but if the stock is gone he is out of the play.

Concentration (Memory)

This is an excellent game for any number of players of any type—serious players, casual players, even people who have never played cards before.

Number of Players—Any number from two up.

The Pack—52 cards.

The Deal—Any player shuffles the pack and lays all the cards out face down, one at a time, so that no two cards touch or overlap at the corners. The entire surface of the table is usually necessary to make room for all the cards.

level { **Object of the Game**—To take in pairs of cards of the same denomination, as two sixes or two queens.

The Play—The first player may be decided in any way. Each player in turn must turn up any two cards on the table, leaving the first face up until he has turned the second. If the two cards form a pair, he takes them and turns up two more cards. Whenever the two cards he turns up do not form a pair, he turns both cards face down again, leaving them in exactly the same position on the table that they were in when he first turned them. The turn to play then passes to the player at his left.

Scoring—There are alternative methods:

(a) The player who takes in the greatest number of pairs receives one counter, or chip, or point, from each other player in the game; if two players tie for the highest number of tricks, they split the winnings.

(b) Each player collects one counter from each other player for every pair he has taken in.

Old Maid

This game is a perennial favorite with children.

Number of Players—Any number from two up, each playing for himself.

The Pack—51 cards (a 52-card pack with one of the four queens discarded).

The Deal—Any player shuffles the pack and deals them around, one at a time to each player, as far as they will go; they do not have to come out even.

level { **Object of the Game**—To form and discard pairs of cards, and not to be left with the odd card at the end.

The Play—Each player removes from his hand, in twos, all pairs of cards (with three sixes a player may remove only two of them). The dealer then offers his hand, spread out face down, to the player at his left, who draws one card from it. This player discards any pair which may have been formed by the card drawn, then offers his own hand to the player at his left. Play proceeds in this way until all cards have been paired but one—the odd queen, which cannot be paired—and the player holding that card is the Old Maid.

Irregularities—If any player discards two cards which are not a pair, causing three unpaired cards instead of one to remain at the end, the player who committed the irregularity is the Old Maid.

Gin Rummy

This has become the most popular two-handed variant of the Rummy family. It is the favorite among all games with the motion picture, radio and theatrical world.

Number of Players—Two. Three may participate in the same game, usually with one sitting out while the other two play. Four or more, in pairs up to almost any number, may play a partnership game (see the rules on page 118), but this is done by playing separate two-hand games and combining scores.

The Pack—52 cards. Two packs should be used, so that while one player deals the other shuffles for the next deal.

Rank of Cards—K (high), Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2, A.

Value of Cards—Face cards, 10 each; ace, 1; other cards their pip value.

The Shuffle and Cut—One pack is shuffled and spread, and each player draws a card; if he draws one of the four cards at either end, he must draw again. If the cards drawn are otherwise of the same rank, the suits rank: spades (high), hearts, diamonds, clubs. The player drawing the high card has choice of cards and seats, and whether or not he will deal first. Either player may shuffle, the dealer having the right to shuffle last. Non-dealer must cut the pack.

The Deal—Dealer gives the cards, one at a time, face down, alternately to his opponent and to himself until each has ten cards; the next card, called the *upcard*, is placed face-up in the center of the table, and the remaining cards, called the *stock*, are placed face down beside it.

level { **Object of Play**—To form *matched sets*, consisting of three or four of a kind, or of sequences of three or more cards of consecutive rank in the same suit.

The Play—Non-dealer plays first, and the turn to play alternates thereafter. In each turn, a player must draw either the upcard (top card of the discard pile) or the top card of the stock, and then must discard one card (which may not be an upcard he has drawn in the same turn) face-up on the discard pile.

On the first play, if non-dealer does not wish to take the upcard he must so announce and dealer may have the first turn by drawing the upcard; if dealer does not wish the upcard, non-dealer draws the top card of the stock and play proceeds.

WORKSHOP **G**

creating classification experiences

The purpose of this workshop is to give you a chance to create subject area experiences related to levels of development.

For each of the appropriate levels of classification abilities, create an experience for the students you are now teaching. (This means that you might not create experiences for some of the abilities listed). You might try to do this for particular subject areas such as mathematics, science, or social studies.

In the following listing are two samples: a resemblance sorting experience designed for students in a pre-school or kindergarten class; a horizontal reclassification experience in mathematics for students in junior high school.

Resemblance Sorting (Kindergarten)

Purpose: At the end of this experience, students will be able to: 1) identify and name the primary and secondary colors, 2) match two objects on the basis of color.

Procedure: Provide students with an assortment of paper cups of the same size and shape but of different colors (red, blue, yellow, green, orange, purple). Introduce another cup that matches by color one of those in the assortment. Ask a student to find a cup that matches it, then let him explain his reasoning for the selection.

Consistent and Exhaustive Sorting

Purpose:

Procedure:

Multiple Class Membership

Purpose:

Procedure:

Class Inclusion

Purpose:

Procedure:

Horizontal Reclassification (Junior High)

Purpose: To introduce the Distributive Property in mathematics

Procedure: Show on a chalkboard, the following idea - To name a sum where the addends have a *common factor*, one may first multiply the *common factor* and then add

$$(3x4) + (7x4) = 12 + 28 = 40$$

or one may add and then multiply by the *common factor*

$$(3x4) + (7x4) = (3+7) \times 4 = 10 \times 4 = 40$$

Give students the following exercises to work.

Name the sums and products.

1. $(3 \times 6) + (7 \times 6) =$
2. $(3 \times 10) + (7 \times 10) =$
3. $\left(3 \times \frac{1}{4}\right) + \left(7 \times \frac{1}{4}\right) =$
4. $(3 + 7) \times 6 =$
5. $(3 + 7) \times 10 =$
6. $(3 + 7) \times \frac{1}{4} =$

Hierarchical Reclassification

Purpose:

Procedure:

WORKSHOP **H**

matching experiences to levels of development

The purpose of this workshop is to give you the opportunity to assess curriculum experiences in terms of classification abilities. It is hoped that you will become skilled in matching experiences to levels of cognitive ability.

The following experiences involve sorting, grouping, or classifying. Read each experience and try to identify the minimal developmental level of a student who is able to do each experience successfully.

You might wish to compare your identifications with those made by staff members on the following page.

Experience 1

Have a student find the two identical (or most alike) objects which are mixed within a set of different objects. After matching objects, ask the student to state a reason for the selection.

Experience 2

Distribute the following materials: banana, orange, orange colored marshmallow, orange jawbreaker, orange button, orange lifesaver, orange gum. Have a student remove one item from the set and tell what the remaining items have in common. Do this for each of the items in the set.

Experience 3

Prepare a set of picture cards which show pictures of objects whose initial consonant sound is "m". Also include pictures whose initial consonant sound is other than "m". Add a few more pictures which illustrate words that rhyme with some of the words in the "m" group as well as with some of the assorted sound group. Show the pictures to a student and ask him to find all the pictures which belong in the "m" group (Don't say the letter name, just make the sound). Next, have the student find all the pairs of rhyming words and group them together.

Experience 4

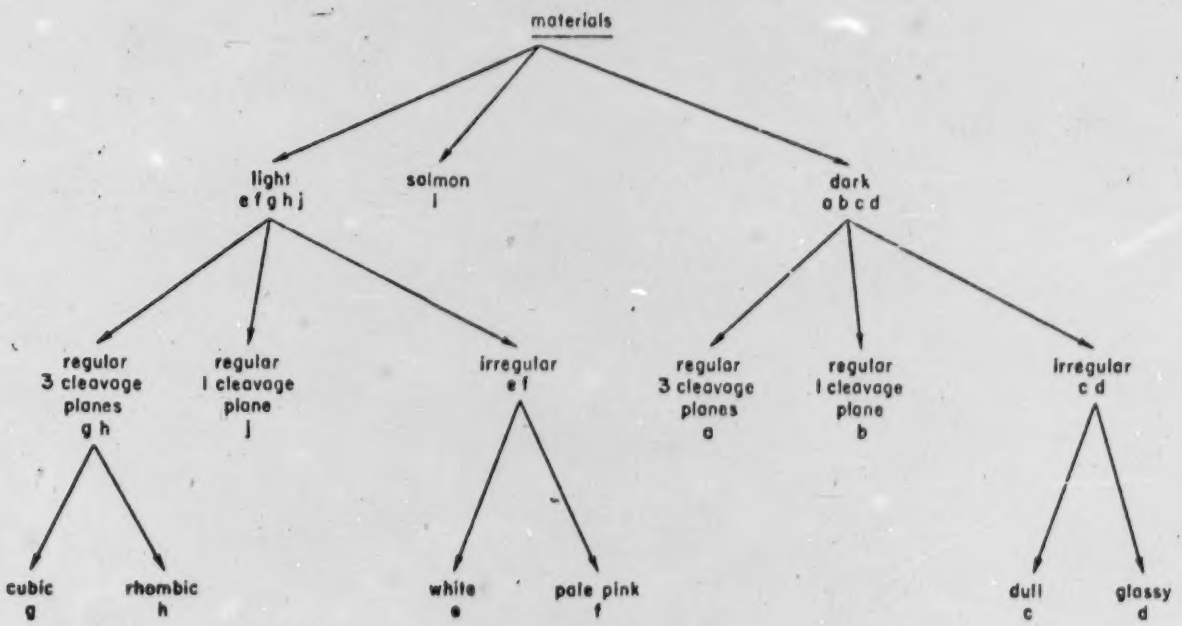
Prepare a box of beads of various sizes, shapes, colors, and materials. Be sure that for every bead there is a matching bead. To begin, select one bead from the box and thread it on a string. Have a student find a matching bead in the box and add it to the string. Let the student tell why he selected the bead, then ask him to place a bead of his own choice on the string. When this is done, another student can search for the matching bead. Students can continue taking turns doing this activity.

Experience 5

Provide the students with the ten materials listed in the chart. Let the students determine the properties of the materials using hand lenses and by testing. Next, ask them to develop a classification system based upon their findings. (One possible system is shown below). When finished, provide another material that was not part of the original set. Ask students to add the new material to their classification system so that it is logically included.*

CHART OF MATERIALS

Code Letter	Properties	Name
a	metallic luster, gray, cubic cleavage	galena
b	black, cleavage in one plane (flakes)	biotite
c	brittle, black, irregular fracture	anthracite coal
d	gray or black, transparent at edges, glassy, irregular fracture	obsidian
e	white, glassy, irregular fracture	milky quartz
f	pale pink, glassy, irregular fracture	pink quartz
g	white, cubic cleavage	halite
h	white, rhombic cleavage	calcite
i	salmon pink, opaque, cleavage in two planes	orthoclase
j	transparent or light, cleavage in one plane	muscovite



*This experience was adapted from the Princeton Project "Time, Space, and Matter." McGraw-Hill Publishing Company, 1969.

ANALYSIS OF CLASSROOM EXPERIENCES

1. Resemblance Sorting Level. In this experience, the student is asked to put two objects together because they are alike in some way. Experiences requiring one-to-one relationships involve students at the resemblance sorting level of classification abilities.

2. Horizontal Reclassification Level. This experience asks the student to classify, then reclassify the same group of objects in numerous ways without constructing subgroups. Note that all the objects become involved in complex multiple class membership relationships.

3. Multiple Class Membership Level. This language arts experience requires the student to concentrate simultaneously upon two or more characteristics related to symbols and sounds. Although it is more complex than just multiple class membership thought, this level of development is a minimal requirement for doing the experience successfully.

4. Resemblance Sorting Level. This is a simple copying or matching experience. Students are given a clue object and are asked to find one other to match it.

5. Hierarchical Reclassification Level. This science experience has the student arrange (and perhaps rearrange) a set of objects into a useful hierarchy (useful in the sense that unclassified objects can be added to the structure) involving increasingly more inclusive classes.

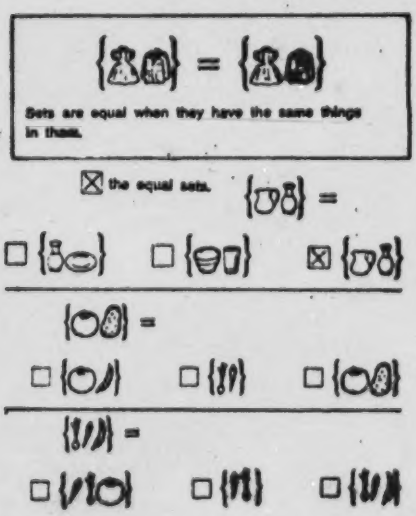
WORKSHOP I

identifying classification abilities related to mathematics

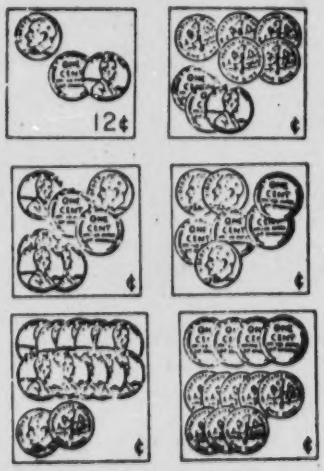
The purpose of this workshop is to give you practice in identifying cognitive operations asked of students by various mathematics programs. After this workshop, you should be able to recognize what classification abilities are asked of students by such math programs and to sequence the tasks according to stages of development.

On this and the next two pages are several samples from various mathematics programs. Identify the level of classification ability required for a student to do each sample successfully, then number the samples to represent a developmental sequence.

SAMPLE I[1]
Level of ability _____
Number in sequence _____



SAMPLE II[2]
Level of ability _____
Number in sequence _____

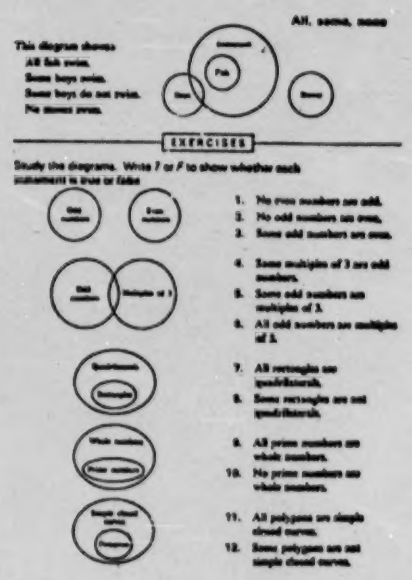


[1] Suppes, Patrick and Joanne Suppes. Sets and Numbers 2. California State Series, Sacramento, 1970.

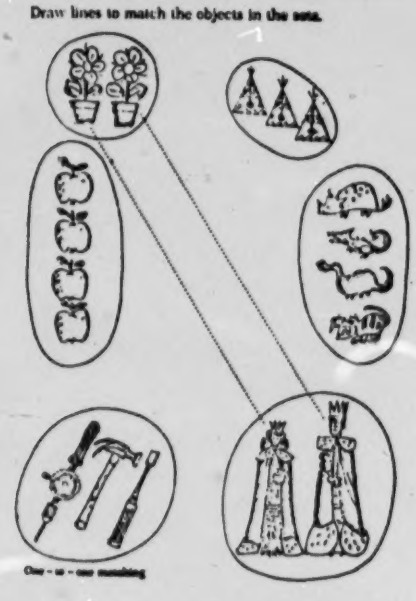
[2] Wirtz, Robert et al. Math Workshop Level A. California State Series, Sacramento, 1964.

SAMPLE III[3]
Level of Ability _____
Number in Sequence _____

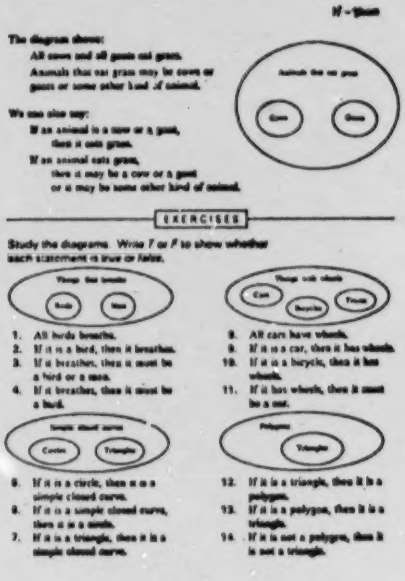
SAMPLE IV[4]
Level of Ability _____
Number in Sequence _____



SAMPLE V[5]
Level of Ability _____
Number in Sequence _____

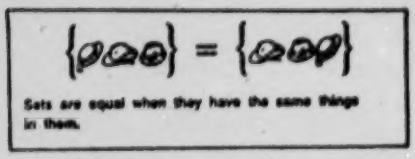


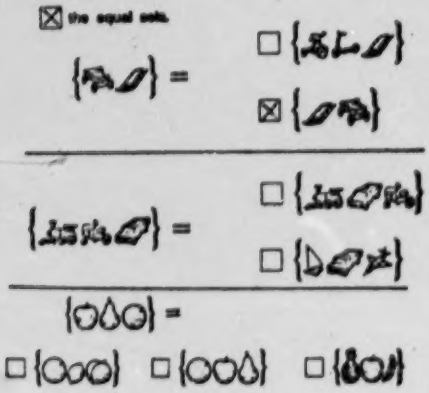
SAMPLE VI[6]
Level of Ability _____
Number in Sequence _____



3 Suppes. op cit.
4 Calif. State Series. Modern School Mathematics, 4. Sacramento, 1970
5 Calif. State Series. Modern School Mathematics, T. Sacramento, 1970
6 Calif. State Series. Modern School Mathematics, 4. Sacramento, 1970

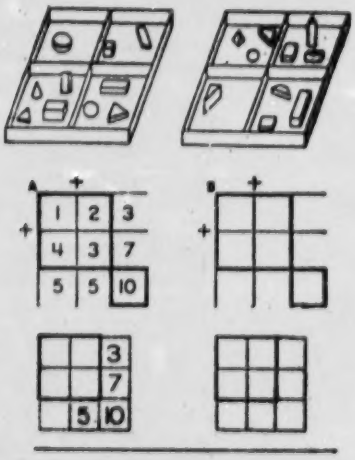
SAMPLE VII[7]
Level of Ability _____
Number in Sequence _____



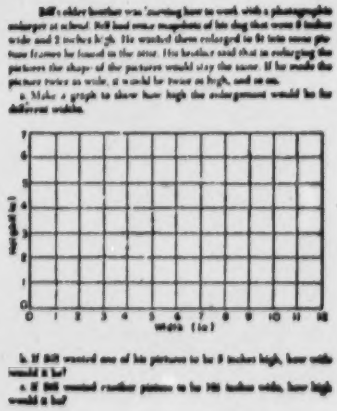


SAMPLE VIII[8]
Level of Ability _____
Number in Sequence _____

SAMPLE IX[9]
Level of Ability _____
Number in Sequence _____



SAMPLE X[10]
Level of Ability _____
Number in Sequence _____



7 Suppes. op. cit.
8 Calif. State Series. Modern School Mathematics, 4. Sacramento, 1970
9 Wirtz, op. cit.
10 Elementary School Science Project. Coordinates, Part IV. Univ. of Calif., Berkeley, 1964.

ANALYSIS OF MATHEMATICS TASKS

SAMPLE I: This task, for successful completion, requires the student to at least be at the Resemblance Sorting level of cognitive development. In this sample, identical sets are matched on a one-to-one basis.

SAMPLE II: This is a Class Inclusion/Whole is Equal To The Sum Of Its Parts task. Students must recognize coins of different values and combine the values to attain a total.

SAMPLE III: This Consistent and Exhaustive Sorting level task asks students to identify all sets consistently using the concept of six.

SAMPLE IV: This task involves the intersections of two sets and subsets, thus requires Multiple Class Membership and Class Inclusion levels to do the task with understanding.

SAMPLE V: This task requires matching on a one-to-one basis, thus is a Resemblance Sorting task.

SAMPLE VI: This task involves subsets or sets within sets as well as intersections of sets. The highest level of ability needed to do this task successfully is the Class Inclusion/Whole Is Equal To The Sum Of Its Parts level.

SAMPLE VII: This is a Resemblance Sorting task similar to Sample I, but slightly more difficult in that the objects are not in the identical order in each of the sets to be matched.

SAMPLE VIII: This is a Horizontal Reclassification task because it requires students to distribute and redistribute factors within an equation.

SAMPLE IX: This Multiple Class Membership level task asks students to work addition problems in two directions, then sum their totals at an intersection.

SAMPLE X: Graphing requires students to work with two variables at once to locate or interpret points in a two-dimensional space. This type of graphing requires that students be at the Multiple Class Membership level to understand the information.

The following indicates a numerical sequence for the above tasks according to levels of development.

1. SAMPLE V
2. SAMPLE I
3. SAMPLE VII
4. SAMPLE III
5. SAMPLE IV
6. SAMPLE IX
7. SAMPLE X
8. SAMPLE II
9. SAMPLE VI
10. SAMPLE VIII

WORKSHOP **J**

introducing the concept of "horizontal instruction"

The purpose of this workshop is to: 1) introduce the idea of "horizontal instruction" (instruction designed to match a particular level of cognitive development); 2) provide a variety of horizontal instructional examples for one level of development; 3) allow for practice in creating other horizontal instructional experiences.

For each of the developmental levels described in this book, a variety of "horizontal" (same level) experiences can be developed. It is possible to create or select from available resources, materials that range from firsthand, concrete experiences, to pictorial or indirect experiences, to symbolic or abstract experiences related to a particular level of cognitive development.

	CONCRETE EXPERIENCES Seeing, Hearing, Feeling Smelling, Tasting	PICTORIAL EXPERIENCES	SYMBOLIC EXPERIENCES
Resemblance Sorting			
Consistent and Exhaustive Sorting			
Multiple Class Membership	← Horizontal Instructional Experiences		→
Class Inclusion			
Horizontal Reclassification			
Hierarchical Reclassification			

The following pages present sets of possible resemblance sorting activities that can be used as models for the development of horizontal experiences at other developmental levels. Specifically, each set of activities contribute toward reading readiness.

INSTRUCTIONAL ACTIVITIES
DESIGNED FOR THE RESEMBLANCE SORTING LEVEL
OF COGNITIVE DEVELOPMENT:

CONCRETE EXPERIENCES

Instruction that involves students in firsthand, perceptual experiences, can span all the senses: seeing, hearing, feeling, smelling, tasting. The experiences can be structured in several ways: by presenting a clue and asking the student to find a matching object; by providing an array or reservoir of different objects among which two are identical and asking the student to find the two that are alike; by selecting objects that have very fine discriminating properties; by arranging objects so that their spatial orientations vary.

Some sample ideas follow.

Visual Resemblance Sorting Experiences

The visual properties of objects that can be selected and controlled in instructional situations are: size, shape, color, and pattern. Although students might begin with grossly different objects, fine discriminations can be later used to sharpen perceptual awareness. Fine discriminations might involve closely matching lengths of sticks, serations or venations of leaves, complex designs, shades or tones of colors.

1. Clue Given: Show students a leaf. Have them find a matching leaf (on the basis of shape) from a collection of differently shaped leaves.

2. Clue Given: Buttons, coins, or other small objects can be glued to heavy cardboard. Ask students to find the two objects that are alike (Figure 1). Finer discriminations among the objects can be developed by selecting ones that are more closely alike (Figure 2).

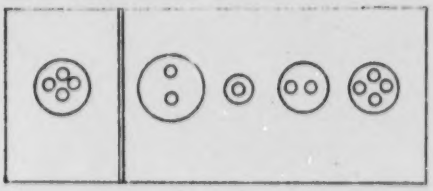


Figure 1

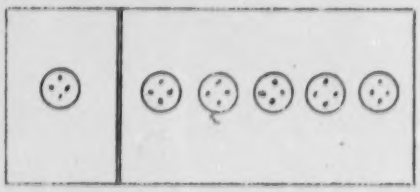


Figure 2

3. Clue Given: String beads (identical in size and color but different in shape) on a string. Every time you string a bead, have a student string a matching bead.

4. Clue Not Given: Prepare a collection of polished, colored stones of similar size (include two stones that are identical in color). Ask students to find the two that look the same on the basis of color.

In the space below, create two more visual experiences, one using a clue and one not using a clue.

a. Clue Given:

b. Clue Not Given:

Auditory Resemblance Sorting Experiences

Auditory properties that can be matched on a one-to-one basis are: pitch, intensity, and rhythm.

1. Clue Given: Have students listen as you play a single note on a musical instrument. Ask them to identify a matching note from a number of notes played in a series.

2. Clue Given: Using a pencil, tap simple rhythms on a desk. After students listen to the rhythms with their eyes closed, have them use pencils to repeat the rhythm that you tapped.

3. Clue Not Given: Before playing a series of 7 notes on a musical instrument, ask students to listen and record the numbers of the two notes among the 7 that sound alike. (You might have to repeat the series several times).

Now create two more auditory experiences.

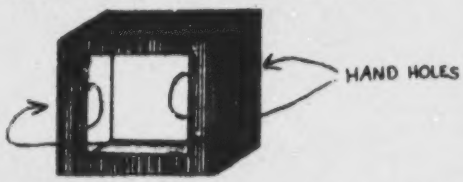
a. Clue Given:

b. Clue Not Given:

Tactile Resemblance Sorting Experiences

Tactile properties have the greatest range of instructional possibilities. Materials can be selected to emphasize such aspects as size, shape, or textures (e.g., roughness, stickiness, softness, sharpness, etc.).

1. Clue Given: Prepare about 8 squares of sandpaper, identical in size, but different in grade (roughness). Place the squares in a "feely box". Give students another square that matches, on the basis of roughness, one of those in the box. Ask the students to find the matching square. For finer discriminations, you might try using different grades of emery paper.



2. Clue Not Given: Place about 8 wooden dowels of equal length but of different diameters within a "feely box". Be sure that two dowels have identical diameters. Have students use their sense of touch to locate the two that feel the most alike.

Try to invent two tactile resemblance sorting experiences.

a. Clue Given:

b. Clue Not Given:

Olifactory Resemblance Sorting Experiences

Our sense of smell is not as acute as that of many other animals, and smells are generally described by naming the object that gives off the smell (e.g., "It smells like a skunk"; "It has a mint smell").

1. Clue Given: Place 6 to 8 bars of scented soaps into different containers. The bars should be identical in size, shape, and wrapped so that they cannot be distinguished on the basis of color. Place one more bar in another container and ask students to find, by smelling, the matching container within the set.

2. Clue Not Given: Wrap differently scented candles that are identical in size and shape. Place 6 to 8 of them into boxes or cans. Add one additional box containing a candle that matches one of the others on the basis of its smell. Mix the boxes and ask students to find the two that smell alike.

For practice, create two more experiences involving the sense of smell.

a. Clue Given:

b. Clue Not Given:

Gustatory Resemblance Sorting Experiences

Generally our sense of taste is combined with our sense of smell. Other than the basic tastes of sweet, sour, bitter, and salty, flavors become complex combinations interwoven with our sense of smell.

1. Clue Given: Give each student his own set of 4 small cups containing salt water, sugar water, quinine water, and water with lemon juice in it. Hand each student a 5th cup containing a liquid that matches in flavor, one of those in the other 4 cups.

2. Clue Not Given: Blindfold students. Let them taste 4 or 5 different foods (e.g., slice of lemon, cherry, orange, lime, pineapple). Next, give each a Lifesaver that matches one of the previous flavors. Ask them to identify which of the previous flavors it matches.

Here's your chance to create two more. (Wine tasting activities are not allowed).

a. Clue Given:

b. Clue Not Given:

PICTORIAL EXPERIENCES

Instruction that does not involve students in firsthand (concrete) experiences but which represents the concrete by an illustration or photograph, is essentially an indirect experience. As with concrete experiences, pictorial experiences can be structured in several ways: by presenting a clue and asking the student to find a matching picture; by providing a reservoir of pictures among which two are identical and asking the student to find the two that are alike. Illustrations can also be drawn to involve students in making fine discriminations, or illustrations can be arranged to provide different spatial orientations.

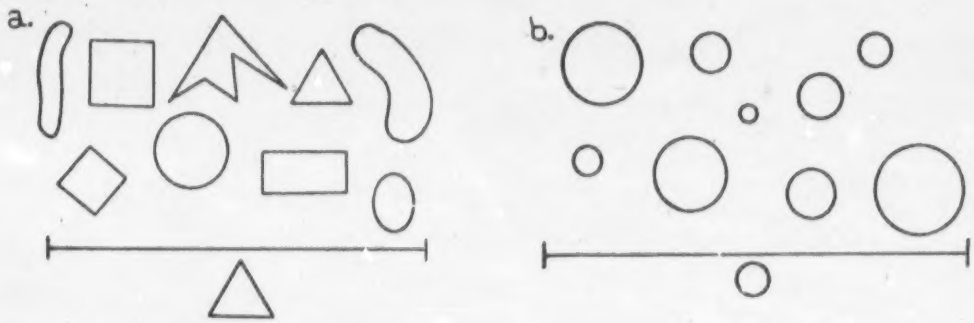
Some sample ideas follow.

Pictorial Resemblance Sorting Experiences

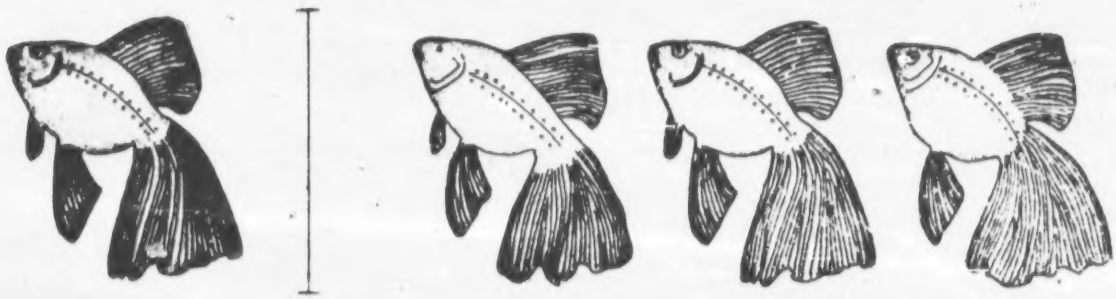
Only visual properties as described earlier (size, shape, color, pattern) can be utilized within pictorial experiences. These properties are a limitation of pictorial experiences.

Each of the following examples asks students to find one picture that matches another picture.

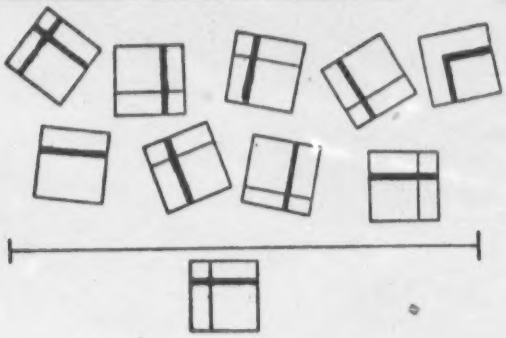
1. Clue Given:



2. Clue Given, Fine Discrimination:

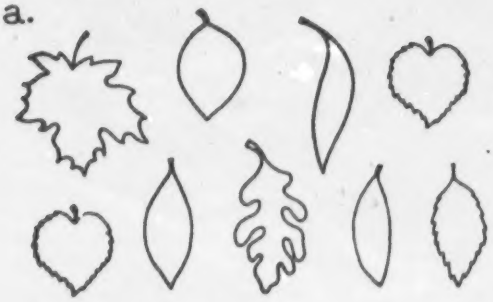


3. Clue Given, Different Orientation:

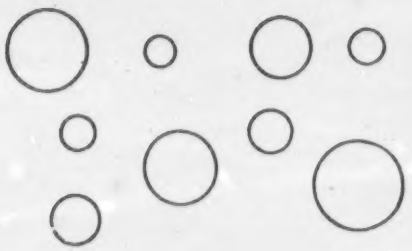


4. Clue Not Given:

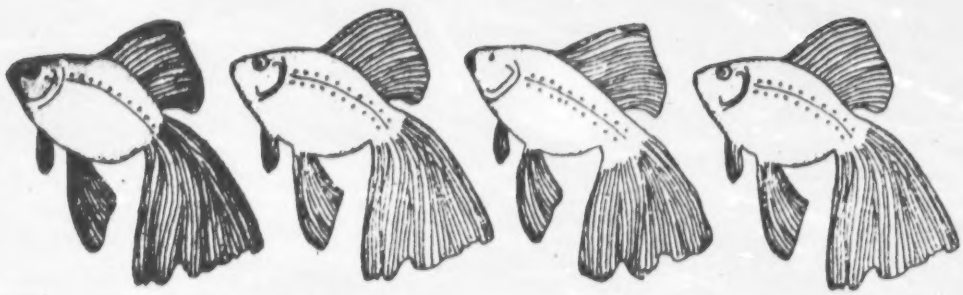
a.



b.



5. Clue Not Given, Fine Discrimination:



6. Clue Not Given, Different Orientation:

SYMBOLIC EXPERIENCES

Symbolic experiences are very indirect. Since symbols stand for something else, the experience is never firsthand, and it requires prior experience or knowledge to comprehend the experience. This is perhaps the greatest limitation to symbolic experiences. It is possible, however, to mix symbolic experiences with concrete or pictorial experiences.

Some sample ideas follow:

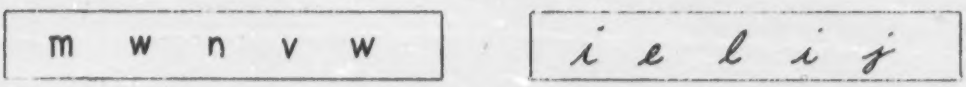
Symbolic Resemblance Sorting Experiences

All the sensory properties described for concrete experiences can be conjured up through symbolic experiences.

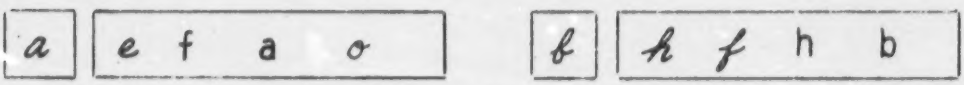
For each of the following, students are asked to find the symbol (letter, word, or words) that matches another symbol.

1. Clue Given, Identical Single Letters:

2. Clue Not Given, Identical Single Letters:

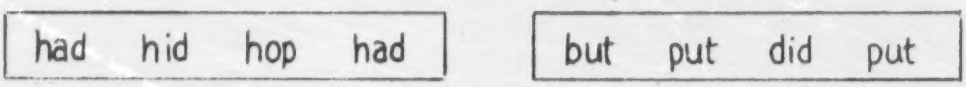


3. Clue Given, Different Single Letters:



4. Clue Given, Identical Configurations:

5. Clue Not Given, Identical Configurations:



6. Clue Given, Different Configurations:

hat	hop hit hut hat		sit	site sat sit set	

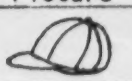
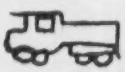
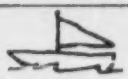
7. Clue Not Given, Different Configurations:

run ran sun ran		Bill fill hill bill

8. Clue Not Given, Semantics:

		Same	Different
See me run.	See me run.	_____	_____
Look at them.	Look at these.	_____	_____
Open the door.	Open the floor.	_____	_____
Go right now.	Go right now.	_____	_____

9. Clue Given, Symbolic/Pictorial: Provide a reservoir of words, one of which matches a real or illustrated object. Ask the students to match each object with the word associated with it. NOTE: In this example, the student must distinguish among similar appearing words (fine discrimination).

Picture	Words		
	coop	cop	cap
	track	truck	train
	boat	boot	beat

10. Clue Given, Symbolic/Concrete: Make certain vowel sounds. Ask students to distinguish among a set of vowels, phonetically marked, and mark the vowel that matches each sound you make.

The samples presented in Workshop J were selected to give you a feeling for the almost limitless range of instructional possibilities for a particular level of development. Certainly many more can be created beyond what was presented here.

The samples were also selected to match one subject matter area - reading. Reading readiness and the sequential lead into actual reading have been emphasized because of their importance to the learner. Many of the ideas presented here are also useful for helping students in need of remedial work in reading.

REVIEW OF SOME RESEARCH ON CLASSIFICATION ABILITIES

Prolog

Classification abilities, together with interpretive abilities and associative thinking, are important aspects of the cognitive processes by which man organizes and connects together the input from his environment. Classification (or categorization, or grouping, or sorting) is of great importance in everyday thinking because it is a necessary preliminary to concept formation, the process by which we make sense of our environment through the realization of what things go together. This deliberate classification is of practical value for it limits the amount of information with which we need to concern ourselves.

Concepts are learned by sorting, in an appropriate fashion, the information that is received through our senses; thus concepts are simply classifications of stimuli that have one or more common characteristics or attributes. Bruner, Goodnow, and Austin (1956) state that to classify "*is to render discriminably different things equivalent, to group the objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness.*" And McDonald (1965) states that once a repertoire of concepts is available, they "*serve as devices for sorting information, and this sorting process determines the way in which the person will organize new information into new concepts.*"

According to Wallace (1965), grouping skills are necessary not only for effective conceptualization, but are also necessary for "*reasoning, since so much of the verbal behavior often vaguely called 'abstract thinking' appears to consist of reasoning about classes and class membership. This includes mathematical reasoning since numbers are classes of classes.*"

Log

Interest in classification abilities began during World War I with a study of impairment of abstract behavior. It was discovered that the abstracting ability of brain-damaged patients differed markedly from that of normal individuals. Eventually various sorting tasks were developed for diagnostic purposes (Halstead 1940). Subsequent to the analysis of performance changes in brain-damaged patients, these tests were used with normal individuals of all ages for the study of concept formation, particularly with children, where a striking parallel was found to exist between pathological and child thought.

Concept Formation Studies

Since the early studies, the major area of research using classification tasks has dealt with concept formation. Within this research, the majority of work has been limited to empirical determinations of classificatory performance of individuals at different ages. These studies of concept formation have been summarized by Vinacke (1952), Werner (1957), Wallace (1965), and Kofsky (1966).

A typical empirical study was carried out by Annett (1959). She used 303 children between 5 and 11 years of age and 42 adults between 18 and 73 years of age. Her sorting test consisted of 16 cards with uncolored line drawings, 4 of which depicted animals, 4 plants, 4 vehicles, and 4 articles of furniture. Each subject was instructed to *"Sort the cards into groups so that the ones that go together are in the same group."*

The more than 200 combinations of cards which were produced illustrated well the problems of interpretation facing the experimenter dealing with classification tasks. Half the 200 combinations occurred only once. Examples of all types of sortings were found in all age groups. A complete four-by-four sorting into animal, plant, vehicle, and furniture groups was made by only 24 children and 11 adults, and only one child and one adult made a complete two-by-eight sorting into living and non-living things. Annett determined that:

a. The number of sorting combinations produced was reduced as age increased.
b. The content of the explanations given did not change with age.
c. The structure of the explanations or the ways the facts were used in relating objects together, changed with age.

The explanations given by the subjects were found to be of five types: 1) no explanation, 2) enumeration (different facts given about each object in turn), 3) continuity (objects related together in a direct, concrete interaction based on place, time, animal, or human

activity), 4) similarities (a characteristic common to the objects is given), and 5) class names. The adults generally (although not always) gave explanations acceptable for correct, logical thinking, but the older adults performed more like children in that they gave more enumerations and contiguities. The order of development of the five types of explanations remained the same whether the data were analyzed for age or for intelligence.

Concept formation apparently involves learning how to discover and select attributes, that is, classificatory criteria, appropriate to the matter at hand and "*learning to deal with relationships among these attributes*" (Elementary Science Study 1966). Whiteman (1962) believes that concept formation must mean sensitivity to the common features forming a class. The criteria for classification must be carefully chosen by the individual himself for the particular situation so that the resulting concepts are of maximum value to him and lead to effective thinking.

Evidence which indicates that the ability to form class concepts is the most fundamental cognitive process can be summarized as follows:

1. The attainment of class concepts is relatively independent of verbal props. For example, grouping is recognized in the behavior of children as young as 1 1/2 years (Stott 1961) and in non-verbalizing organisms lower on the phylogenetic scale such as Macaque monkeys (Andrew and Harlow 1942). Wallace (1965), however, points out that only elementary levels of classification, that is grouping of objects on the basis of shape and color, can

be entirely independent of language, and that the more advanced classificatory operations cannot be attained without a verbal basis. Again, a study by Oleron (1956) showed that deaf-mute children between 5 - 8 years were as successful as normal children in classifying by color, shape, and size, but experienced great difficulty in classifying at a more abstract level.

2. Lovell (1955), using a battery of classification tests, reported strong evidence that the ability to categorize was not adequately measured by conventional factors.

3. Class concepts, at least the elementary ones, remain virtually unaffected by variations in the cultural and socio-economic enviornment (Goodenough 1962; Price-Williams 1962).

Visual Classification Studies

It is quite clear that the visual aspects of objects play an important role in how the objects are sorted or classified.

Lowery and Allen (1969, 1970, 1973) found that for first graders, shape is visually an easier attribute to handle than pattern, and pattern is easier than size. In addition, they found that it was much easier for the child to use a single attribute rather than two attributes simultaneously and that two attributes could be handled more readily than three. Most importantly, they found that situations in which positionings or fine discriminations were used as ordering attributes required abilities which the children did not yet possess. It

may be that these abilities are never acquired for certain objects or stimuli, particularly those that are not part of one's everyday environment.

Askham (1972) found that 9 - 12-year-old students classified plants growing in a semi-natural outdoor environment differently than they classified objects in a classroom setting. Moreover, the degree of classificatory stimulation engendered by specific plants was dependent upon their distinctive characteristics and their physical proximity to the student. The setting and/or the naturalness of objects may influence the ways in which the objects are classified.

Shifting of visual attributes may be an important facet of the classification process. Schell (1971) found that students attend to one attribute at a time when stimuli vary in several attributes but that when required to, they learn to shift quickly from attribute to attribute. Bryant (1966) found that children below the age of six shifted between dimensions (e.g., color to shape) more easily than they could shift between stimuli within a dimension (e.g., blue color to green color).

A study with deaf children indicated that shifting within a dimension is easier for older students and adults and is easier than shifting from one stimulus dimension to another (Youniss 1964).

Most studies of visual classification abilities have demonstrated that broad conceptual abilities appear at given age levels, or in some sequential order, or in association with cultural or pathological char-

acteristics. Gardner (1953), A. E. Goldman and M. Levine (1963), E. Hanfmann and J. Kasanin (1937), Price-Williams (1962), and many others have sought to reveal patterns of development related to broad categories of age, experience, training, and sex, but all have also neglected to document what Lowery and Allen define as horizontal fine structures — the degrees of difficulty within a level of ability. To Lowery and Allen (1973), horizontal fine structures may consist of task oriented variables such as shape, color, pattern, function, and value, or they may focus upon the learner in which case, age, sex, and socio-economic status become the relevant dimensions.

Loggins (1974) explored horizontal fine structures by seeing if there were performance differences, due to socio-economic status and sex, age, and task variables, among 7 - 8-year-old children on visual multiple class membership tasks. He found that upper and middle socio-economic status students performed better than lower socio-economic status students; lower SES boys outperformed lower SES girls; upper and middle SES girls outperformed boys; all students did better on tasks involving differences than on tasks involving similarities.

Socio-Economic Status Studies

In a study of lower and middle-class children, it was found that classificatory success was dependent, in part, on the mode of presentation; failure increased when the children were presented with colored pictures of objects to be grouped rather than the objects themselves

(Sigel, Anderson, and Shapiro 1966). It was concluded that lower-class children had not yet acquired adequate mental representations of familiar objects. Yet both groups of subjects verbalized their responses equally well. It was found that there was no significant difference in verbal responsiveness as a function of I.Q.

In a study done with kindergarten children of high and low socio-economic status, Johnson (1968) found that both could consistently categorize on the basis of attribute resemblance, especially when the attribute of shape was involved. The mastery of categorization, Johnson concludes, is both necessary and natural and begins with birth and not with entrance into school.

Working with underprivileged children in Israel, Sharan and Weller (1971) found that girls emerged superior to boys on all measures and lower-class children generally employed color as a determinant for grouping more than did middle-class children. In the United States, Lowery and Allen (1970) found that upper socio-economic status first grade girls performed better than boys on tasks pertaining to single and double variables of shape, pattern, and size. Both studies found that lower-class children were less able to achieve the required conceptual depth when compared with their middle-class peers.

Cultural Studies

The data available on color and size studies transcend cultural boundaries. Schmidt and Nzimande (1970) found "*overwhelming incidence of*

color preference" in their study of Zulu children and illiterate farm workers. The results were remarkably similar to those obtained by Suchman (1966) in his study of Hausa (African) children attending traditional (not Western-type) schools. Bruner et al (1956) report that Greenfield, Reich, and Oliver, using different types of tests, came to similar conclusions about unschooled Wolof Bush children. In effect, they found that the use of color as a grouping attribute increased with age and that the use of form and functional attributes was virtually non-existent at any age. In addition, the Wolof illiterate adults demonstrated the same reliance on color attributes as the Zulu farm workers.

Color again appears to be the dominant determinant in forming classification schemes in Price-Williams study of Tiv (African) children. In his study, however, he disregards this attribute and concentrates his attention on the concrete attributes of "*legs*," "*domesticity*," and "*edibility*" in animals and "*roots*," "*two-leafed*," and "*from the earth*" in plants. From this study it appears that primitive children, even when exposed to Western-type education, classify objects on the basis of the object's relationship to their livelihood. Price-Williams also found that Tiv children express a growth in the capacity to reach the state of concrete operations when they have had an opportunity to manipulate familiar materials. Furthermore, this growth proceeds at a similar rate in both schooled and illiterate children and compares favorably with European children. In effect, these results add

credence to the work done by Piaget and his associates in Geneva.

Studies by Lovell, Mitchell, and Everett (1962) have repeated Piaget's experiments in other countries and confirm the classificatory levels of conceptual development. Although differences do occur with different cultural backgrounds, the order of levels remains constant.

Epilog

Inhelder and Piaget (1964) describe three stages of conceptual development through which classification abilities are sequentially attained. In Stage I the child groups classifiable material into figural collections in which the collection "*looks like a train*" or "*looks like a face.*" In Stage II the figural collections give way to non-figural collections. The child now sorts or groups objects on the basis of similarity of single attributes (e.g., size, shape, or color). In Stage III the child can mentally handle two or more attributes simultaneously and can eventually keep in mind that a subclass is included in a superordinate class but does not exhaust it.

Kofsky (1966) and Allen (1967) used scalogram analysis to test the substages within Piaget's theory. This book contains those substages in which both experimenters found agreement with Piaget's work.

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